Millers 1966

BIOLOGICAL EVALUATION OF JACK-PINE BUDWORM

ON THE HURON-MANISTEE NATIONAL FORESTS, 1966

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A. INTRODUCTION

The jack-pine budworm is in the fourth year of outbreak and is expected to continue into 1967. On the Huron National Forest budworm population is declining, but some local severe defoliations are expected. Ample budworm is expected on the Manistee National Forest, however, defoliation is not expected to result in severe tree mortality.

The recommendation for 1967 is to locate areas where tree mortality is occurring and to conduct salvage operations where feasible.

B. TECHNICAL INFORMATION

1. Causal Agent
   Jack-Pine Budworm, Choristoneura pinus Freeman.

2. Tree Hosts
   Jack Pine, Pinus banksiana Lamb.
   Red Pine, Pinus resinosa Ait.
   Scotch Pine, Pinus sylvestris L.
   Eastern White Pine, Pinus strobus L.

3. Type of Damage
   Larval feeding on pine foliage is the primary damage. Weakened trees may be attacked by secondary organisms. The following basic groups of effects may be considered:

   a. tree mortality
   b. top-kill of jack pine
   c. reduced increment
   d. killing and maiming of understory reproduction and underplanted red pine
   e. reduction in red pine cone crop

   Tree Mortality was reviewed at length in our 1965 biological evaluation of the jack-pine budworm. It indicated that past mortality of trees in Michigan was light. However, here evidence is presented that losses from current outbreaks are economically significant. Table I shows budworm mortality from five jack pine stands sampled on the Mio Ranger District. All were severely defoliated in 1963 or 1964. The cord volumes shown represent actual harvestable volume of trees recorded according to accepted point-sample timber cruise practices.

Table I. Merchantable volume lost from 1963-64.
Jack-pine Budworm Defoliation on the Mio Ranger District.

LOCATION			AREA	MERCHANTABLE VOLUME			
T.	R.	Sec.	CRUISED	Live Cds/A.	Dead Cds/A.	% Lost	Cords Lost
25	1E	29	45	5.2	2.1	28.4	95
26	1W	32	120	9.0	2.0	18.3	240
26	2W	4	80	13.8	3.2	18.7	256
25	2W	6	31	9.7	1.5	13.3	47
25	2W	6	46	5.8	0.5	7.8	23

It is noted, that the cruise areas were selected for heaviest losses, although similar stands in the area that had been similarly defoliated had estimated mortalities like in the cruise areas. This cruise was made to show that jack-pine budworm defoliation can cause mortality like reported in the other Lake States.

Several points of interest are brought out from these surveys. Mortality of trees appears to be more severe in denser pine stands than in the open. (The first area in the table was well stocked, since large red pines were present but are not included in the report.) The apparent explanation is the smaller tree crowns in dense stands than in open grown stands. The latter tended to be more top-killed.

Tree mortality does not occur immediately following defoliation. Attached pictures show the same area after '63 defoliation and the resultant kill in 1966. Apparently, completely defoliated trees may die in one or two years, but trees with few needles left may die in two or three years.

Another observation shows that jack pines are not severely defoliated two years in a row. First year defoliated tree does not produce staminate flowers the following year. Although overwintering budworm population may be high, lack of staminate flowers causes extensive larval mortality in the spring. Consequently, some additional feeding takes place, but generally, budworm populations are low during the following one or two years on this tree. Moderately defoliated stands have some budworm trees and some budworm-free trees, for several years. This may appear as if the trees are defoliated repeatedly, while actually, defoliation is changing from tree to tree annually. The heavily defoliated stands sampled for tree mortality from '63-'64 defoliation, were defoliated again in 1966, and consequently, tree mortality is expected to double.

Final comment on tree mortality concerns the remaining trees that survive the defoliation. When a jack pine stand of 17 cords per acre loses 3 cords per acre from budworm, the losses are significant, and at going stumpage value are estimated at $10 an acre. However, if 3 cords were lost in a stand containing 6 cords per acre, the whole stand is lost, since the remaining wood cannot be harvested commercially because of the low volume. The losses then would be about $21 per acre.

Top-kill of jack pine is most common among open grown trees. Trees in dense stands have crowns on the upper 1/4 or 1/5 of the total height. In the open, live branches are found on 3/4 to 4/5 of the tree. Consequently, budworm seldom completely defoliates a large crown tree and partial kill may result. If moist seasons follow, these partial killed trees survive and develop new crown, of course, some height loss occurs. In dry years, however, secondary organisms, particularly bark beetles, kill the whole tree. Bark beetle damage is common on the Huron National Forest where defoliation occurred in 1963-1965.

Increment loss may be the most important budworm damage, but stand data are not available that relate degree of defoliation with number of cords of growth lost. This subject is discussed in 1965 evaluation, as reviewed from Kulman et al. (1963). The latter studied individual trees and the results are not directly applicable to a group of trees. However, estimates can be made for relatively evenly defoliated stands. Severely defoliated stands can expect negligible volume increment on surviving trees for at least two years. Since most stands on the Huron National Forest have been defoliated at least once at least moderately, the total increment loss is estimated 0.1 cords per acre for two years on 146,000 acres; i.e. about 29,000 cords worth about $87,000. Of course, this is an estimate, but the actual amount could be more.

It should be pointed out that the growth loss does not include volume lost by direct death of the tree.

Understory seedlings and planted red pine are severily damaged by budworm larvae. The fallen larval climb on the small trees and defoliate them. In addition, bark and buds are damaged. As a result, branch and top-kill of small seedlings is common. The economic losses on jack pine are not severe since slightly crooked stems are not culled for pulpwood. However, red pine is grown for utility poles and sawlogs, where sweeps and crooks devaluate the tree.

Cone damage may occur from larvae feeding on the conelets and from reduced pollen production. The significance of this damage has not been evaluated.

4. Biological Data of Budworm

The summarized life cycle of the jack-pine budworm is as follows: Adult moths emerge late June or early July and lay eggs on the older needles of jack pine. Examinations in 1966 show that eggs are abundant on red pine also, even when about 1 mile away from nearest jack pine. Shortly, young larvae hatch and search out overwintering sites, loose bark and cone scales. There, they spin loose webbing, hibernacula, molt into second instar and hibernate. There is no feeding in the fall.

In the spring young larvae emerge and move to staminate flowers. The flowers provide suitable shelter and early diet. While larvae can survice without staminate flowers, the mortality rate apparently is high and usually population decrease occurs.

After staminate flowers have dried out and new shoots begin to expand, i.e. about the third larval instar, most larvae move out to the vegetative shoots. This is usually in early June. The third and fourth instar larvae feed on the new needles, but damage usually is not severe. Heavy defoliation occurs during fifth and sixth larvel instars, usually after mid-June. Last week of June, larvae popate and in one to two weeks new adults emerge.

The spring of 1966 was unusually cool, and consequently host and budworm development was delayed about two weeks. In addition, considerable variation of larval instars were found at any one time. This presents problems in control application where fourth instar is considered the earliest susceptible stage. In 1966, the chemical application was timed to the period when majority of larval have transferred from staminate flowers to vegetative shoots, rather than the instar of the larval.

Number of insect enemies are known for jack pine budworm, but their total effect is not clear.

Primary egg parasite is Trichogramma minutum Rly. While 5 - 10% parasitizm is recorded, its affect on outbreak population is not known.

The overwintering larvae are attacked by Apanteles fumiferanae Vier., with parisititizm near 20%. However, outbreak populations still continue (Mac Aloney et al, 1956).

Mature larvae are parasitized by the fly, Lypha setafacies (West.)

Prime pupal parasite is Itoplectis conquisitor (Say.) that kills from 10 - 30% of the pupae.

There is a host of other parasites, but only the more important are mentioned.

Virus diseases are suspected of reducing budworm outbreaks, but published literature is lacking.

The epiphytology of the jack pine budworm is not well understood. Usually, outbreak appears relatively suddenly, persists for 2 - 4 years, and then rapidly decline. The course of the outbreak populations are difficult to predict. Drastic population declines may occur during the winter, during early feeding, and shortly before fourth and fifth instars. For this reason frequent surveys are required before chemical suppression is applied.

Defoliation survey: Aerial detection surveys provide valuable information on budworm. This survey was made in mid-July on the Huron-Manistee National Forests defoliation. The attached maps show three levels of jack pine budworm defoliation and also areas where trees appear dead or dying. However, defoliation within these areas is not uniform but is determined on the basis of general impression from the air.

Egg Survey: The egg survey is made in August or September after the eggs have hatched. One hundred eight sample plots were located on the Huron National Fore st and 49 on the Manistee National Forest. Six 18 inch long branches from mid-crowns of three dominate and co-dominate trees were examined for budworm egg masses. The results were 0.20 egg masses per twig on Huron National Forest and 0.42 e.m./t. on Manistee National Forest. This compares with 0.72 e.m./t. and 0.96 e.m./t. for the same areas in 1964 (see attached graph). It is difficult to say what these population levels mean. According to Wisconsin system of evaluation, egg mass populations in excess of 0 - 5 e.m./t/ are expected to result in severe defoliation, unless larval mortality is heavy (R. B. Stewart, Wisconsin Conservation Department, personal communication). Huron National Forest population appears declining, but locally ample budworm populations are still present to cause severe defoliation. The budworm population on the Manistee National Forest has decreased but severe defoliation can be expected where budworm was not abundant this year.

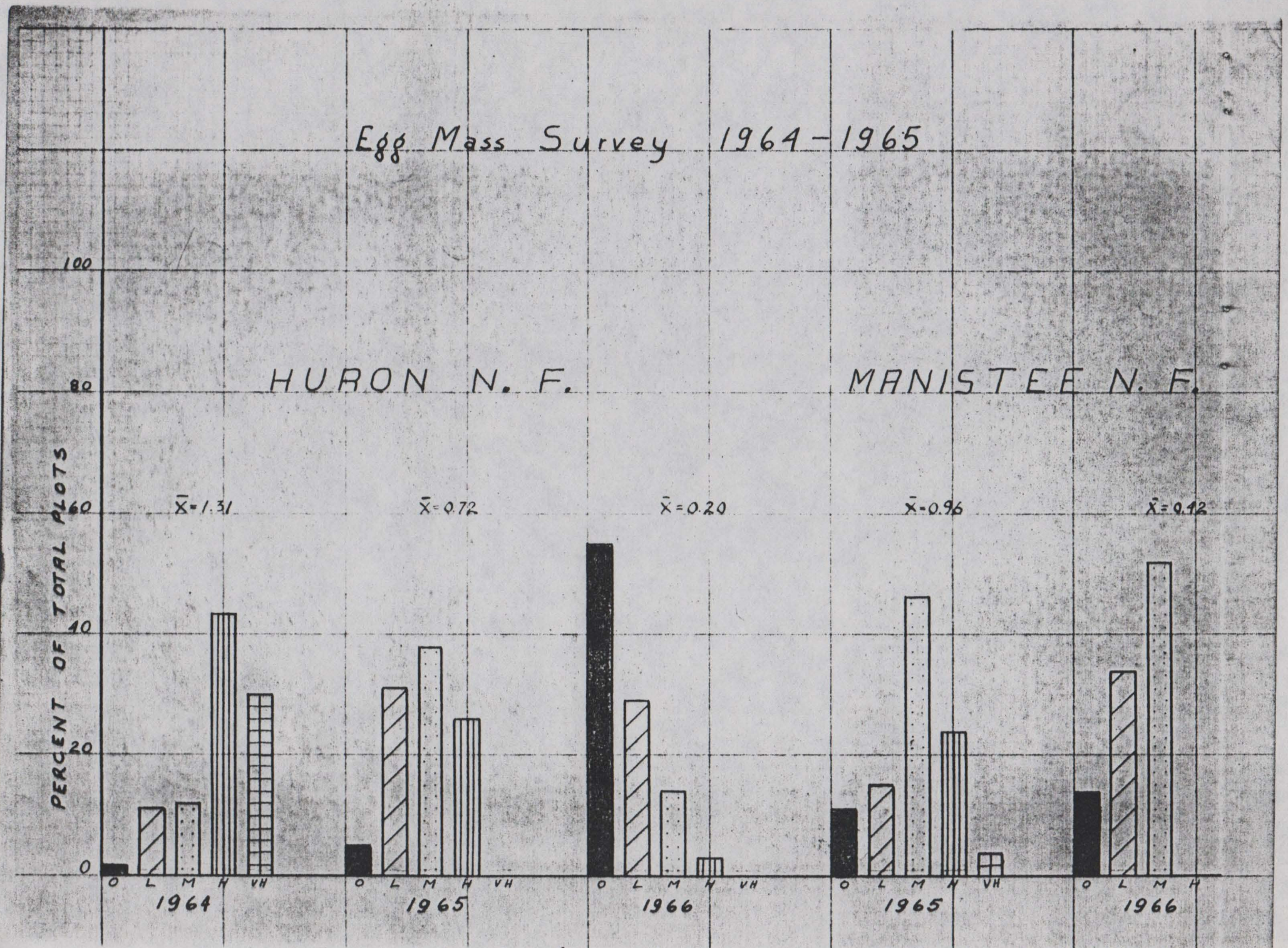
Staminate Flower Survey: The second and third instars of larvae can be surveyed when staminate flowers of jack pine are expanded. Generally a select number of lower branches within reach are sampled. About 15 staminate flowers and 15 vegetative shoots per plot are examined for budworm larvae. More than 10 larvae would indicate high budworm population.

Experience on Huron-Manistee National Forests has shown that larval counts can be high at this stage, but unless staminate flowers are abundant, population may decline rapidly. It is suggested that instead of larval survey at this time, an aerial survey is made to determine areas where staminate flowers are abundant. The second instar larval survey then need be done only in the areas where staminate flowers were abundant.

Fourth and Fifth Instar Larval Surveys: Several larvel surveys may be desired before application of insecticides. All these surveys are similar except for timing. The survey consists of pre-selected sample plots in pine stands considered for spraying. Six 18" branches are cut from mid-crown of three dominate and co-dominate pine. The branches usually are cut with twig clippers attached at the end of extension poles. A bag is attached near the clippers to prevent extensive disturbance and loss of larvae. More than three larvae per twig could cause severe defoliation where previous damage is noticeable, but pines with good compliment of foliage should be able to bear up to five larvae per twig.

Suppression Surveys: Pre and post spray surveys must determine the effectiveness of the suppression project. An adequate estimate can be made by sampling ten shoot clusters on each of five trees per plot. The samples may be taken from branches within an easy reach. Five to ten plots on a line across expected flight pattern should suffice. Post-spray samples should be in close proximity of pre-spray sample plots, but exact replication is not required.

Egg Mass Survey 1964-1965



5. Environmental Factors

Jack pine budworm outbreaks appear to be most closely related to the availability of staminate flowers.(MacAloney and Drooz, 1956). However, abundance of flowers does not necessarily assure budworm outbreak, instead it provides for better success in survival (Hodson and Zehngraff, 1946); Heron and Nairu, 1965, observed in Prairie Provinces (Canada), that some flowering occurs annually, but occasional heavy or sparce flowering years occur. They also report that budworm defoliation decreases flowering and that trees with orchard-type crowns provide more staminate flowers than normal crowned trees. Abundance of flowering on the more open trees is also reported by Graham (1935), Benjamin et al, (1962), and Kulman et al. (1963).

The open-grown jack pine may support more budworm, but tree mortality is common in denser pine stands. The open-grown trees have larger crowns and more foliage, and consequently, partial crown kill rather than complete kill is more common. In the dense stands, pines have smaller crowns and complete defoliation occurs more frequently.

The stand condition, such as open grown trees and overmature trees, may favor budworm buildup. However, budworm defoliation during an outbreak is likely to occur in any type of jack pine stand - even in dog-hair jack pine about 20 years old. On the Huron-Manistee National Forests budworm caused damage is most severe in dense stands over 25 years of age.

Budworm defoliation on red pine is common. Usually, the red pine is in mixture with jack pine. Tree mortality does not occur when red pine is the same size as the jack, but top-kill is common where the red pine is suppressed by the jack pine. This situation is common on the Forest because the jack pine seems to grow faster in early stages.

Weather may be the most important factor in budworm epiphtology, but very little is known of its influence.

6. Location and Intensity of Outbreak

Defoliation survey was made in last week of July. Some budworm defoliation was present throughout the Forest, but only the medium and heavy defoliation was sketch-mapped. Medium defoliation was considered in stands where both green and brown color was easily visible. When green color was barely perceptible, defoliation was classed as heavy. The distribution of the defoliation is shown in the attached maps.

On the Huron National Forest defoliation in 1966 has declined. Only Mio Ranger District had wide-spread defoliation. Many of the areas were defoliated for the second time during the current epiphytotic, and tree mortality is expected.

The Manistee National Forest defoliation was more wide-spread this year than in 1965. However, very little tree mortality is expected. The most significant damage occurs in the Kellogg Area of the Cadillac Ranger District where suppressed red pine is top-killed.

C. DISCUSSION AND RECOMMENDATION

The jack-pine budworm outbreak shows signs of decrease. Generally, 1966 defoliation was less intense than in 1965. The egg mass counts showed considerable decline on the Huron National Forest, and some decline on the Manistee National Forest. Survey results indicate that locally severe defoliation can be expected in 1967.

Tree mortality as a result of the past defoliation is expected to continue. Salvage operations appear to be the only thing possible where commercial volumes are affected.

Chemical suppression is not recommended unless timber values of jack pine increase considerably over previous years.

D. LITERATURE CITED

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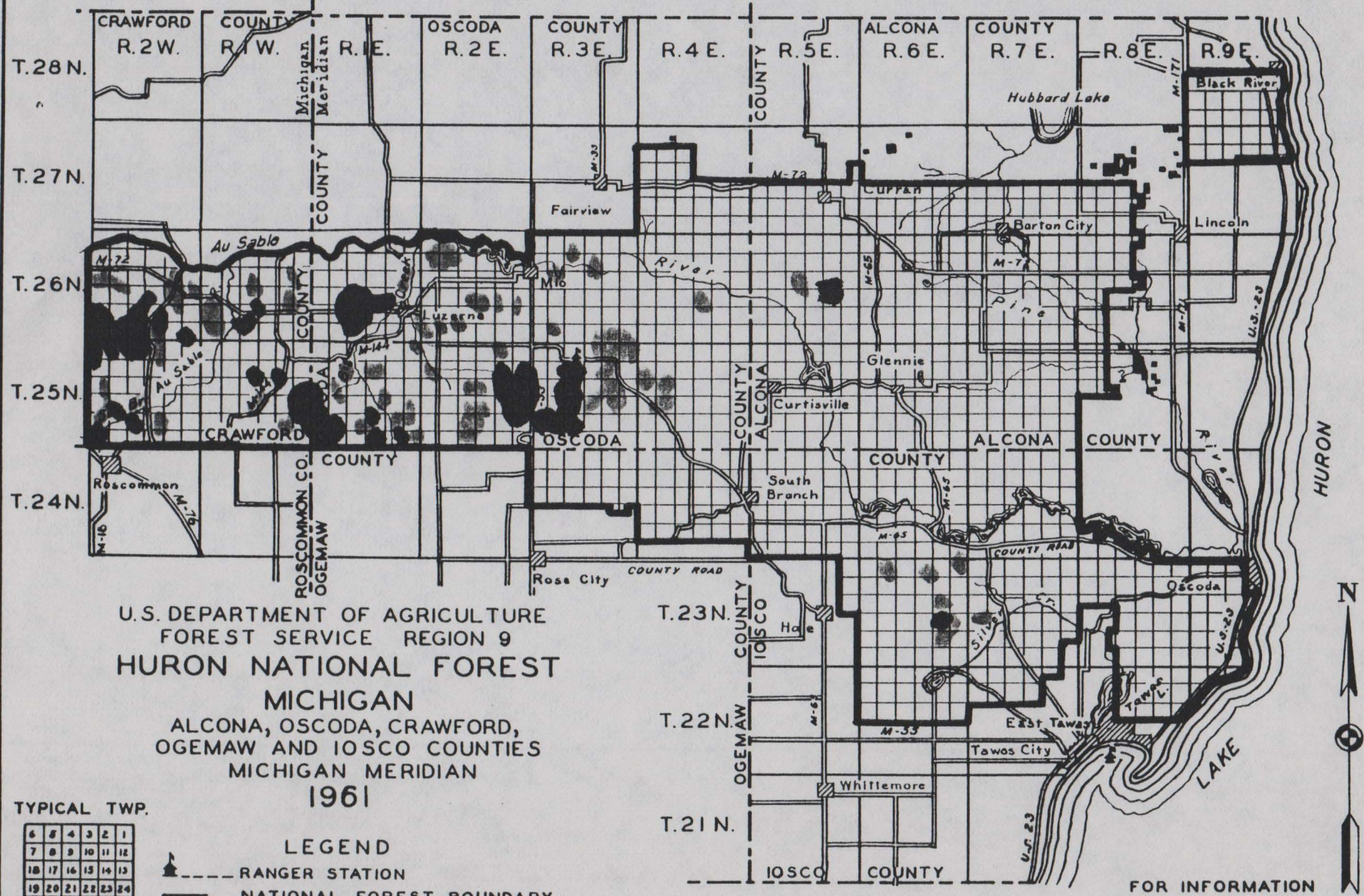


U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE REGION 9

HURON NATIONAL FOREST
MICHIGAN

ALCONA, OSCODA, CRAWFORD,
OGEMAW AND IOSCO COUNTIES
MICHIGAN MERIDIAN
1961

TYPICAL TWP.

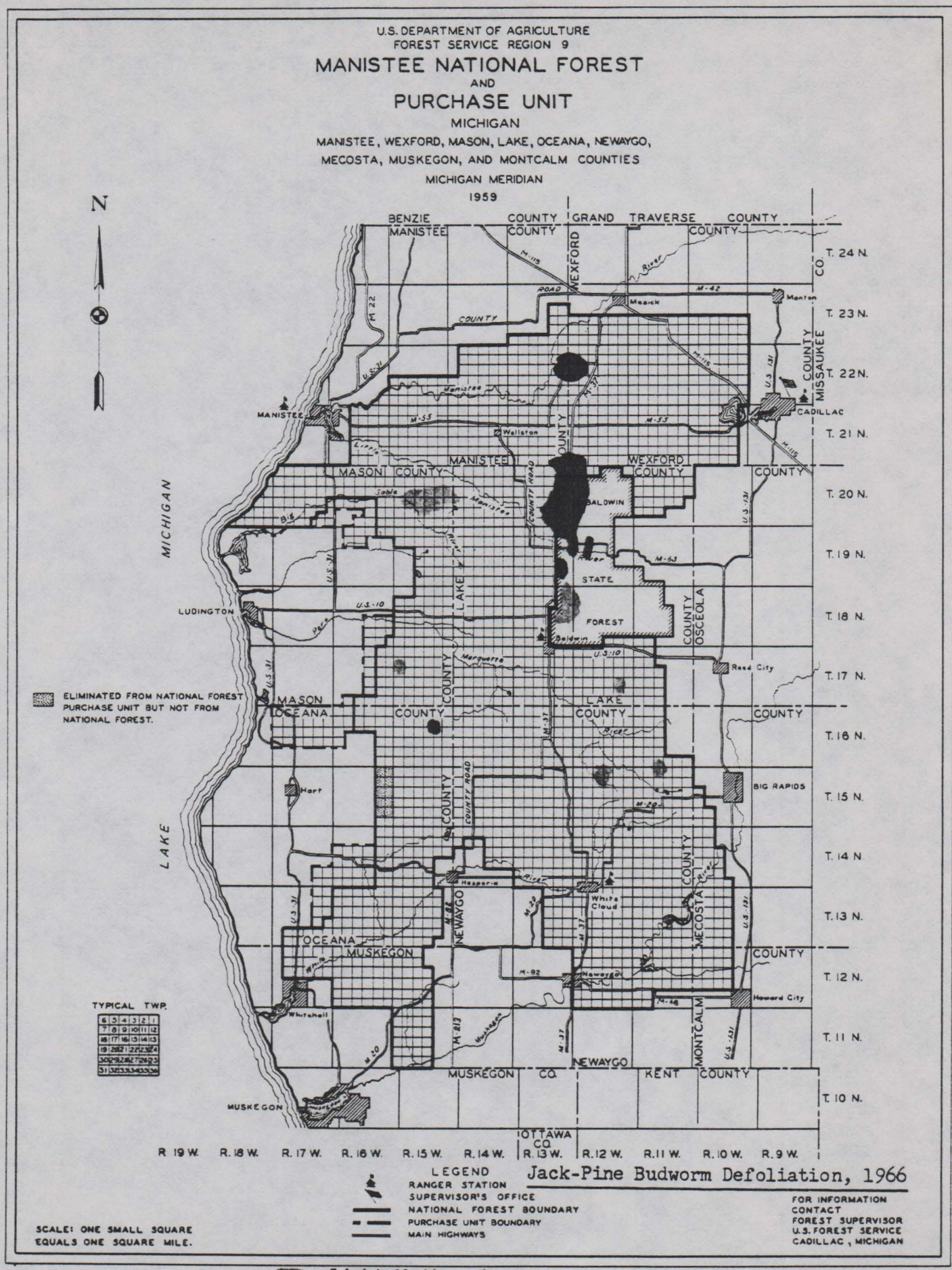
6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

LEGEND
- RANGER STATION
- NATIONAL FOREST BOUNDARY
- MAIN HIGHWAYS

Jack-Pine Budworm Defoliation, 1966
=Medium, mostly brown, but green visible.

E: ONE SMALL SQUARE EQUALS ONE SQUARE MILE.

FOR INFORMATION
CONTACT
FOREST SUPERVISOR
U.S. FOREST SERVICE
CADILLAC, MICHIGAN



Light-Medium, brown & green
Medium to heavy, mostly brown with some green visible.